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Levels of Bifurcation of the Sciatic Nerve among Ugandans at School of Biomedical Sciences Makerere and Mulago Hospital Uganda

J. Kukiriza, H. Kiryowa, J. Turyabahika, J. Ochieng C.B.R. Ibingira

Makerere University, School of Biomedical sciences Department of Anatomy, P.O Box 7072, Kampala Uganda,

Correspondence to: J. Kukiriza jhukukiriza@yahoo.co.uk and CBR.Ibingira-, cibingira@yahoo.com

Background: The sciatic nerve is derived from the lumbo-sacral plexus, It is the thickest nerve in the whole body, it exits the gluteal region through the lower part of the greater sciatic foramen, it is the main innervator of the posterior thigh, the leg and foot, it usually ends halfway down the back of the thigh by dividing into the tibial and common peroneal nerves, and these terminal branches supply the leg and foot. The position of division of this nerve varies, it may occur within the pelvis, gluteal region, upper and mid thigh, and distal thigh. Its injury if it involves the whole nerve, may lead to loss of sensation, in posterior thigh, whole leg and foot, with loss of function of all muscles in posterior thigh, whole leg and the foot. And this results into failure to dorsiflex the foot a condition referred to as foot drop. The level of bifurcation of the sciatic nerve above the transverse popliteal crease is useful during sciatic nerve block, hence the need for healthcare workers to have adequate appreciation of the applied anatomy of the nerve. The main objective of the study was to determine the level of bifurcation of the sciatic nerve above the transverse popliteal crease among Ugandans at Mulago Hospital Complex.

Methods: This was a cross-sectional descriptive study conducted at the Department of Anatomy, School of Biomedical sciences, Makerere University and Mulago Hospital mortuary. Eighty adult cadavers were dissected in the gluteal region and posterior thigh to establish the level of bifurcation of the sciatic nerve above the transverse popliteal crease, and the distance from the crease was measured in cm using a caliper calibrated in millimeters.

Results: Eighty left lower limbs of 56 male and 24 female adult cadavers were dissected to expose the sciatic nerve one side of the body was dissected to control for left to right variations, however in another study, the variations on two sides would be compared.. The heights of the cadavers ranged from 145 to 182 cm with a mean of 162.8 cm. The nerves bifurcated in the gluteal region and posterior thigh in 62 cadavers (77.5%) and 18 in the pelvis (22.5%). Of the 62 nerves that bifurcated higher in the pelvis, the level of bifurcation ranged between 3.8 and 32.5 cm but most of the bifurcations occurred between 3.8 and 12 cm above transverse popliteal crease. In four of the nerves that exited the gluteal region after bifurcation, the nerves reunited before the final bifurcation occurred in the thigh.

Conclusions: The Bifurcation of the sciatic nerve occurs at variable distances from the transverse popliteal crease and appreciation of these variations is essential. More than 22% of all nerves leave the pelvis as two separate nerves and therefore the sciatic nerve trunk cannot be wholly traced or used for anesthetic block in the gluteal region or thigh for procedures in the leg and foot. Only 62 individuals (77.5%) had sciatic nerves in the gluteal region and thigh, and within this group, the vertical distance of bifurcation ranged between 3.8 and 32.5 cm transverse popliteal crease.

Introduction

The sciatic nerve is the largest nerve in the body and is the main nerve from the lumbosacral plexus comprised of the tibial (L4, 5, S1, 2, 3) and common peroneal (L4, 5, S1, 2) nerves. The nerve leaves the pelvis normally by passing through the lower part of the greater sciatic foramen inferior to the piriformis and anterior to the inferior and superior gemelli and the obturator internus muscles. Its terminal branches innervate the structures in the posterior compartment of the thigh, and the region of the lower limb below the knee joint except for the small stretch of skin on the anteromedial aspect of the proximal leg, the knee and ankle joints and all the joints in the foot. The sciatic nerve usually separates into two and sometimes three terminal branches approximately half way or at lower levels of the thigh¹⁻³.

The sciatic nerve is commonly injured during administration of intramuscular injections in the gluteal region (buttocks), and, its bifurcation level above the popliteal fossa crease is considered important by clinicians during sciatic nerve block for surgery of the calf, Achilles tendon, ankle joint and the foot. Thus it is critical to locate its major trunk before it bifurcates, and, applying local anesthesia at that level, usually 5 or 7cm according to the classical teaching^{4,6}. The level of bifurcation of this nerve has not been studied among Ugandans in spite of its clinical significance; hence this study will provide baseline reference data for this population.

This study was aimed at determining the level of bifurcation of the sciatic nerve among Ugandans at the department of Anatomy and Mulago Hospital Complex.

Subjects and Methods

This was a cross-sectional descriptive study conducted at the department of anatomy dissection laboratory, School of Biomedical sciences, Makerere University and Mulago Hospital mortuary. Eighty adult cadavers comprising 56 males and 24 females were dissected from the gluteal region to the transverse popliteal crease to expose the nerve and to determine the levels of its bifurcation above the transverse popliteal crease. Ethical review and approval was sought from the faculty research and ethics committee and informed consent were obtained from the next of keens of the deceased in case of postmortem specimens.

Results

The left lower limbs of eighty adult cadavers were dissected, 56 (70%) males and 24 (30%) females and their heights were determined; the heights ranged from 145 to 182 cm with a mean height of 162.8 (± 1.9 SD) cm (Table 1). The nerves bifurcated in the gluteal region and posterior thigh in 62 cadavers (77.5%) and in the pelvis in 18 specimens (22.5%).



Piriformis

Figure 1. Sciatic nerve components (short arrows) exit the pelvis below piriformis (long arrow) in a bifurcated state (tibial and common peroneal)

Of the 62 specimens where the nerve bifurcated in the gluteal region and posterior thigh, the level of bifurcation above the transverse popliteal crease ranged from 3.8 to 32.5 cm with a mean vertical distance of 8.5cm (± 1.4 SD). Of these 57 (91.9 %) nerves bifurcated between 3.8 and 12cm.

The height of cadavers, however, did not show any relationship with the level of bifurcation of the sciatic nerve from which Pearson chi-square values of 0.810 with a P-value of 0.937 were obtained (Table 2).

Among the 18 cadavers whose nerves bifurcated in the pelvis, four fused again in the gluteal region and posterior thigh before final bifurcation and there was no relationship between height of cadavers and the level of bifurcation of the nerve in the gluteal region as indicated by the Pearson Product Moment Correlation Coefficient. The mean vertical perpendicular distance of bifurcation of the intact sciatic nerve above the popliteal fossa crease was 8.5cm and more than 90% of bifurcations occurred at less than 12 cm (Table 3). In seven specimens, however, the nerves bifurcated outside the mean at 11.5, 14, 20, 23, 27, 32, and 32.5 cm, respectively.

Table 1: Height of cadavers

Height (cm)	Number of cases	Percentage (%)	Cumulative percentage (%)
145.0	1	1.3	1.3
146.0	1	1.3	2.5
148.0	2	2.5	5.0
149.0	1	1.5	6.3
150.0	3	3.8	10.0
151.0	1	1.3	11.3
152.0	1	1.3	12.5
153.0	1	1.3	13.8
154.0	2	2.5	16.3
155.0	2	2.5	18.8
157.0	3	3.8	22.5
158.0	2	2.5	25.0
158.5	1	1.3	26.3
159.0	8	10	36.3
160.0	5	6.3	42.6
161.0	7	8.8	51.3
162.0	5	6.3	57.5
163.0	1	1.3	58.8
164.0	1	1.3	60.0
165.0	3	3.8	63.8
166.0	4	5.0	68.8
167.0	1	1.3	70.0
168.0	2	2.5	72.5
169.0	1	1.3	73.8
170.0	4	5.0	78.8
171.0	2	2.5	81.3
172.0	3	3.8	85.0
174.0	3	3.8	88.8
175.0	3	3.8	92.5
176.0	2	2.5	95.0
177.0	2	2.5	97.5
179.0	1	1.3	98.8
182.0	1	1.3	100.0
Total	80	100.0	

Table 2. The relationship between height of cadavers and the level of bifurcation of the sciatic nerve above the popliteal crease where the nerve bifurcated in the gluteal region and posterior thigh

Height of cadavers in cm	Ranges of bifurcation in cm			Total No of Gases
	0-12	13-23	24-34	
145-160	27	2	1	30
161-176	26	0	2	28
177-192	4	0	0	4
Total	57 (91.9%)	2 (3.2%)	3 (4.8%)	62 (100%)

Note: Pearson's Chi-square value = 0.810, P- 0.937

Table 3. Level of vertical perpendicular height of bifurcation of the sciatic nerve above the transverse popliteal crease in the gluteal region and posterior thigh

Level of bifurcation in cm	Number of cases	Percentage (%)	Cumulative percentage (%)
3.8	1	1.6	1.6
4.0	2	3.2	4.8
4.5	1	1.6	6.4
5.0	8	12.9	19.3
5.5	2	3.2	22.5
6.0	8	12.9	35.4
6.5	7	11.3	46.7
7.0	11	17.7	64.4
7.5	4	6.5	70.9
8.0	3	4.8	75.7
8.5	3	4.8	80.5
9.0	5	8.1	88.6
11.5	1	1.6	90.2
14.0	1	1.6	91.8
20.0	1	1.6	93.4
23.0	1	1.6	95.0
27.0	1	1.6	96.6
32.0	1	1.6	98.2
32.5	1	1.6	100
Total	62	100	

Discussion

The level of bifurcation of the sciatic nerve in the popliteal fossa is considered by clinicians when sciatic nerve regional block is contemplated for surgical procedures in the leg below the knee. The logic behind this is to avoid frequent failures in popliteal block by locating the major trunk of the sciatic nerve before it bifurcates and applying the local anesthesia at that level to anaesthetise the whole nerve. Previous studies have indicated a failure rate as high as 21% of popliteal blocks with many requiring supplementation⁷.



Figure 2. A bifurcation of the sciatic nerve 32.5 cm above the popliteal fossa crease



The sciatic nerve reconstituted in proximal thigh

Figure 3. Common peroneal and tibial nerves come from the gluteal region bifurcated and then fusing again as indicated by the arrow.

In this study the average distance of bifurcation of the sciatic nerve from the transverse popliteal crease was 8.5 cm with a range of 3.8 - 32.5 cm in 62 cadavers. Most of the bifurcations (57 nerves, 91.9%) occurred within a distance of 12 cm above the transverse popliteal crease. This is at variance with the classical teaching where the level of bifurcation is taken to be at an average of 5 or 7 cm above the transverse popliteal crease and which has led to the placement of the needle at 7cm⁵. In a case report, the findings of Nayak (2006) further correlated the classical teaching³. That report had demonstrated a mean level of bifurcation of 6.05 (± 2.7 SD) cm with a range of 0-11.5 cm indicating that some nerves can bifurcate at a higher level than the 7 cm, and therefore implied that when performing popliteal block, insertion of the needle at 10 cm above the transverse popliteal crease is more likely to result in placement of the needle proximal to the division of the nerve than placement at 5 or 7 cm according to the classical teaching³. In the present study, however, it was noted that 18 specimens bifurcated at a much higher level and before leaving the pelvis, while among the remaining 62 cases, 57 (91.9 %) bifurcated between 3.8 and 12 cm above the transverse crease. This finding should be borne in mind when locating the nerve for a regional block in the posterior thigh; and in this population the needle should be placed at the 12 cm mark above the transverse popliteal crease or higher.

The findings of the current study have demonstrated that on average the sciatic nerve bifurcates much higher above the popliteal crease among Ugandans than other studies done elsewhere, and because some of the nerves actually bifurcated even higher in the gluteal region, attempts to block the two components of the nerve at different points should not be overlooked. Employment of modern technology like ultrasound-guided nerve blocks has proved to be more successful and effective⁸⁻¹¹ and should be applied in our population.

Conclusion and recommendations

In this study the sciatic nerve bifurcated in the posterior thigh and gluteal region in 77.5% of the cases and in the pelvis in 22.5%, and the level of bifurcation is independent of the height of the individual. Other variations of the nerve found included, division in the gluteal region and fusion in the thigh, followed by terminal division into the tibial and common peroneal (Figure 3) The use of ultrasound-guided nerve block where total nerve block cannot be achieved due to the variable bifurcation level is recommended.

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